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International hospital productivity comparison: Experiences from the Nordic countries☆☆

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ABSTRACT

This article focuses on describing the methodological challenges intrinsic in international comparative studies of hospital productivity and how these challenges have been addressed within the context of hospital comparisons in the Nordic countries. The hospital sectors in the Nordic countries are suitable for international comparison as they exhibit similar structures in the organisation for hospital care, hold administrative data of good quality at the hospital level, apply a similar secondary patient classification system, and use similar definitions of operating costs. The results of a number of studies have suggested marked differences in hospital cost efficiency and hospital productivity across the Nordic countries and the Finnish hospitals have the highest estimates in all the analyses. Explanatory factors that were tested and seemed to be of limited importance included institutional, structural and technical. A factor that is yet to be included in the Nordic hospital productivity comparison is the quality of care. Patient-level data available from linkable national registers in each country enable the development of quality indicators and will be included in the forthcoming hospital productivity studies within the context of the EuroHOPE (European health care outcomes, performance and efficiency) project.

1. Introduction

Most healthcare services are conducted in the public sector where the usual market signals are absent. Therefore, the execution of systematic comparison of the provision of health care could be helpful for sharing experiences in solving comparable problems and identifying best practices. This type of information should provide evidence for policy makers in identifying optimal structures in the provision and reimbursement of health care. In this way, relevant and comparable performance measures are believed to serve as measures of efficiency or outcomes of various health policies and health care systems. International efficiency comparisons can precede at three levels; system wide, by disease and by subsector

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[1] The list of all researches will be given in near future in our web pages http://eurohope.info/index.html.

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[1]. The subsector approach can provide useful insights on efficiency in delivering given sets of outputs. The usefulness of subsector efficiency analysis depends on how it can be linked with institutional factors as well as how it can be used in benchmarking for managerial purposes, i.e. learning from best practices. An additional relevance criterion is the potential gains that can be achieved with efficiency improvements. At the hospital level, the efficiency can be linked to many important policy questions that form the basis of current health care reforms and recent studies on efficiency indicate significant efficiency potential at the hospital care level. For managerial purposes, hospital-level efficiency measures are in use at least in Australia, Norway [2] and Finland within the context of the yearly reporting of hospital productivity [3]. International comparisons will increase their usefulness and can reveal more information about the cost and productivity structure of a subsector such as hospitals, than a country specific study alone [4]. Furthermore, with an increase in the number of observations and therefore in the degrees of freedom, one gets more variation in explanatory variables and stronger possibilities for exploring causal mechanisms. However, international efficiency comparisons at the subsector level are rare. In a study from 1996 marginal costs in general acute care among US and Canadian hospitals was compared and it was found that production technologies and marginal costs differed significantly between the two countries as well as within the US [5]. Mobley and Magnussen examined the technical efficiency of hospitals in the regulated and public Norwegian sector and the unregulated competitive Californian sector using empirical data from 1997 where it was found that scale and scope regulation improves the long run performance of the system due to a better utilization of capital [6]. In another study a sample of hospitals from the strongly decentralized Swiss hospital sector was compared with a sample from the centralized German sector yielding large efficiency differences in favour of German hospitals [7]. Derveaux and colleagues assessed French and US hospitals and found a large difference in the use of technologies across the countries [8]. The quite substantial differences in observed performance between countries may be due to the dissimilar hospital structures and reimbursement schemes and may also result from methodological and data problems. A reason for the small number of international comparisons is that datasets only to a limited extent are comparable and relevant data is often lacking especially on the output side due to differences in patient and treatment classifications that impede the comparability of outputs. For example, in the Norway–California comparison, a DRG-based output index was not available for all patients in California, and thus the ranking of technical efficiency was dependent much on the specification of output [6]. Even the comparability of inputs may be difficult. For example, in many countries such as the US and Canada, it is common for doctors not to be counted as hospital staff, resulting in the difficulty of including them as physical inputs or including their remunerations in total costs. In addition, when inputs are measured in monetary terms the main question is how to transform national currencies and price levels.

There are numerous conceptual and practical issues to be clarified when seeking to undertake an empirical analysis of efficiency in hospital sector [9–11]. The aim of this articles is to describe the methodological challenges intrinsic in international comparative studies of subsector empirical efficiency and how these challenges has been addressed within the context of hospital comparisons in the Nordic countries. The results then form a basis for recommendations for future studies.

2. Nordic studies on hospital productivity

Within the context of research collaboration across the Nordic countries, i.e. Norway, Denmark, Sweden and Finland, called the Nordic hospital comparison study group (NHCSG), the possibility of conducting international comparisons in hospital cost efficiency has been explored through a number of studies [12–17]. The first study that came out from the group was a comparison of cost efficiency between Norway and Finland [12]. Data envelopment analysis (DEA) was applied onto Finnish and Norwegian hospitals from 1999 and the results revealed marked differences in efficiency both within the countries and between the countries. This study was later updated to include also Swedish and Danish hospitals from year 2002 [15] where results revealed that Finland still held the highest mean cost-efficiency score, the Norwegian and Danish hospitals lagged slightly behind and Sweden held the lowest mean cost-efficiency score. Furthermore, the cost-efficiency at the university-hospital level was assessed separately based on data from 2002 to 2004 including also input and output variables for teaching and research [14]. Results from this study showed that differences at the University level becomes less marked when variables for teaching and research are included. In 2008 changes in hospital productivity in Norway 1999–2004 compared to changes in the rest of the Nordic countries was studied [13]. The results of the study concluded that the Norwegian hospital reform that was introduced in 2002 was associated with a small increase in productivity. The hospital productivity over 2005–2007 was assessed in another study by Kittelsen [16,17] again showing that mean hospital productivity in Finland was higher than in the neighbouring countries and also estimating decreasing returns to scale at the hospital level. Finally, the hospital productivity in 2008–2009 is currently being assessed within the context of the EuroHOPE project where variables for quality also are included in the analysis. Preliminary results indicate no correlation across hospitals between productivity levels and 30 days mortality within each country, although there are clear differences between countries for both variables.

The results have received considerable publicity, in particular the robust finding that the Finnish hospitals perform consistently better. Lessons from the Finnish example, which has integrated municipal ownership of primary and secondary care and extensive use of health centres, may have contributed to some of the policy measures in the 2012 integrated care reform in Norway. The key characteristics and differences of the studies are summarised in Table 1.

Table 1
Key characteristics for the different studies.

Reference	Years included	Objective	Countries included	DMU	No of DMUs included	Inputs	Input price index	Outputs	DRG grouper used	Productivity analysis method	Variables used in a second stage analysis	Efficiency scores
[12]	1999	Hospital cost-efficiency	Norway; Finland	Hospital	No:51; Fi:47	Operating costs	Two separate indices (1; 60% staff, 2; 40% other resources).	Inpatient DRGs; Day care DRGs; Outlier days; Weighted outpatient visits	NordDRG grouper 2000b	DEA (CRS and VRS); Efficiency index model (CRS and VRS)	N/a	All Fi: 0.81–0.92; All No: 0.49–0.92
[13]	1999–2004	Norwegian reform evaluation, Hospital bias corrected technical productivity estimates,	Norway; Finland; Denmark; Sweden	Hospital	No: 256; Fi:230; Dk:54; Sw:188	Operating costs	Three separate indices (1; 20% physicians, 2; 50% nurses, 3; 30% other resources) based on wage indices (1, 2) and CPI (3) all converted to EUR using a PP corrected index from OECD	Surgical inpatient DRGs; Medical inpatient DRGs; Surgical day-care DRGs; Medical day-care DRGs; Outpatients	Country specific NordDRG groupers and cost weights from each country	Bootstrapped DEA (CRS and VRS); SFA	Year dummies; Country dummies; Outlier days per discharge; Activity based financing; Reform dummy	Mean annual technical productivity Fi: 0.76–0.84 (0.74–0.86); No: 0.63–0.68 (0.62–0.70); Sw: 0.55–0.61 (0.54–0.62); Dk: 0.75 (0.72–0.77)
[14]	2002–2004	University hospital bias corrected cost-efficiency	Norway; Finland; Denmark; Sweden	University hospital	No:24; Fi:15; Dk:10; Sw:21	Operating costs; Research grants and costs for teaching	See [13]	Surgical inpatient DRGs; Medical inpatient DRGs; Outpatients; FTE interns; FTE residents; Share of top 5% publications; Field normalised citation score; No. of citations	See [13]	Bootstrapped DEA (CRS and VRS)	Year dummies; Country dummies; Outlier days per discharge; DRG weight > 5; Case-mix index; Super specialised hospital; Visit-to-discharge ratio	Teaching and research CRS model Fi: 0.92 (0.87–0.99); No: 0.89 (0.85–0.95); Sw: 0.88 (0.82–0.98); Dk: 0.92 (0.87–0.98)
[15]	2002	Bias-corrected hospital cost-efficiency	Norway; Finland; Denmark; Sweden	Hospital	No:43; Fi:38; Dk:54; Sw:49	Operating costs	See [13]	Surgical inpatient DRGs; Medical inpatient DRGs; Surgical day-care DRGs; Medical day-care DRGs; Outpatients; Outpatient visits	See [13]	Bootstrapped DEA (CRS and VRS)	N/a	6 output CRS model Fi: 0.80 (0.73–0.88); No: 0.74 (0.64–0.80); Sw: 0.65 (0.53–0.75); Dk: 0.80 (0.68–0.85)

Table 1 (*Continued*)

Reference	Years included	Objective	Countries included	DMU	No of DMUs included	Inputs	Input price index	Outputs	DRG grouper used	Productivity analysis method	Variables used in a second stage analysis	Efficiency scores
[16,17]	2005–2007	Hospital productivity	Norway; Finland; Denmark; Sweden	Hospitals (Fi and Dk); health regions (Sw and No)	No:75; Fi:96; Dk:105; Sw:40	Operating costs	Four separate indices (1; 20% physicians, 2; 50% nurses, 3; 30% other staff, 4; X% other resources) based on wage indices (1, 2, 3) and CPI (4) all converted to EUR using a PP corrected index from OECD	Surgical inpatient DRGs; Medical inpatient DRGs; Surgical day-care DRGs; Medical day-care DRGs; Outpatients; Outpatient visits	See [13]	Bootstrapped DEA (CRS and VRS); SFA	Year dummies Country dummies East-ern/western/ middle geography dummy Outlier days per discharge Case mix index Visit-to-discharge Capital city dummy University-hospital dummy	Mean pro-ductivity against a common frontier Fi: 79.1% (77.0–81.0); No: 56.6% (53.0–58.6); Sw: 52.6% (49.8–54.2); Dk: 57.7% (54.4–59.6)
EuroHOPE Work in progress	*2008–2009*	*Hospital productivity*	*Norway, Finland, Denmark, Sweden*	*Hospitals (Fi,Dk,Sw) and health enterprises (No)*	*No:75; Fi:9; Dk:105; Sw:40*	*Operating costs*	*See* [16,17]	*See* [16,17]	*Common DGR grouper and cost-weights derived from patient level cost data in Finland*	*Work in progress*	*Work in progress*	*Work in progress*

DMU: Decision making unit, DEA: Data envelopment analysis, SFA: Stochastic frontier analysis, CRS: Constant returns to scale, VRS: Variable Returns to scale, Fi: Finland, Dk: Denmark, No: Norway, Sw: Sweden.

3. Practical solutions

In the sections below it is described how the methodological challenges related to requirements for international comparisons have been addressed in the context of the Nordic hospital productivity studies. In all the studies the definition of the DMU is an acute hospital providing a 24 h emergency service and that holds at least two somatic specialities.

3.1. Output measurement

3.1.1. Discharges and visits

For the analysis in all studies the output was generally grouped to five categories: inpatient medical cases; inpatient surgical cases; day care surgical cases, day care medical cases, and outpatient visits. Before grouping the output data, a critical task was to harmonize the definition of a 'discharge' as discharges in Norway and Denmark were defined as 'hospital discharges' while in Sweden and Finland the discharges were defined as 'specialty discharges'. Speciality discharges means that if the patient is transferred to other clinical specialities and department within the same hospital, a new discharge is counted. Swedish and Finnish hospital data were therefore aggregated by merging patient discharge data in cases where clinical transfers were found. The main diagnosis for the hospital discharge was inherited from the speciality discharge that had the largest DRG cost weight. In 1996, the Nordic countries launched a modified Diagnoses Related Group (DRG) system based on the 10th revision of the International Statistical Classification of Diseases and Related Health Problems (ICD-10), together with a new Nordic classification of surgical procedures (NCSP) [18]. With a common Nordic version, each country has its own localised national versions containing national modifications of the ICD-10 and NCSP. In the first comparison the Finnish and Norwegian inpatient admissions and day care episodes in 1999 were grouped using the NordDRG grouper version 2000.b, whereas in the later studies the inpatient admissions and day care episodes in Norway, Finland, Denmark and Sweden were grouped using each country's own NordDRG versions for each year[1] [12–17].

In all studies the variability in DRG groups was processed further by breaking each admission into two distinct parts: the admission itself, which is assumed to contain a higher intensity of care and a standard amount of bed-days, and the last remaining bed-days which exceed a certain agreed standard. In this breakdown of each admission into a standard 'package' and an extra amount of bed-days, an outlier analysis was used. If the inpatient admission exceeded a cut-off point determined by the standard deviation method, the remaining patient days were inserted into a separate variable indicating a type of output which is not properly explained by the DRG classification system.

In addition, slight modifications in the groupings were done, to ensure comparability. First of all, in all cases where DRGs were split into subgroups in the national versions were aggregated back to the original grouping. Secondly, some subdivisions were based on the presence of comorbidities and these were coded to a considerably larger extent in Norway than in the other countries, probably due to the stronger incentives of the Norwegian reimbursement system. Thirdly, in Norway there were considerable volumes in some DRG groups that did not exist in the other countries. For example, the number of normal newborns were grouped and counted as output whereas in other Nordic countries delivery related DRGs included only the hospital discharges for mother's stay at the maternity wards. This was necessary only for the normal newborns since any other types of problems with the newborn would be counted in paediatric DRG groups. In addition, the Norwegian inpatient grouping included significant volumes of rehabilitation, dialysis treatment and radiation therapy. These treatments were provided mainly in day care or outpatient visit settings in the other countries.

In the first study DRG cost weights for inpatient medical and surgical cases were derived from Helsinki-Uusimaa district, which uses patient level cost accounting and covers approximately 30% of all acute hospital care in Finland [12]. Cost items included diagnostic tests, procedures, medical services, support services and overhead costs. In the later studies a common set of fixed weights was applied to all the national DRG groupings, either an average of the national weights for each DRG in 2002 [13–15], or the Norwegian national weights in 2007 [16,17].

In all the studies medical and surgical day care included those cases where the patient did not stay overnight in the patient ward, but where treatment was considerably more resource intensive than for outpatient visits. Day care cases were grouped using the NordDRG grouper and weighted accordingly.

In the Norway-Finland comparison outpatient visits were weighted according to type of specialty (e.g. surgery, internal medicine, obstetrics), where average cost weights were used for each specialty and the type of visit (i.e. emergency visits, scheduled visits) [12]. In the later studies outpatient visits were measured as simple counts without case-mix weighting.

3.1.2. Other outputs

In the study focusing on the performance of the university-hospitals outputs also included clinical teaching activities measured by the number of full-time equivalent (FTE) medical interns and the number of FTE physicians undergoing residency [14]. In addition research activities were included and measured by the results of a bibliometric analysis of the scientific articles and reviews in clinical medicine produced by each university hospital during the period studied. The analysis included both qualitative parameters such as the field-normalised citations score [19] and the number of top 5% publications [20], and the total number of citations [21] per university hospital.

[1] In 2002 Denmark started using a modified DRG system based on NordDRG called DkDRG. The system applies similar rules and is based upon ICD-10 and NCSP. However, at the DRG level it is not comparable or easily convertible to NordDRG. Thus, in one of the studies [13] normalised Danish weights were used for Denmark instead of average Nordic weights. Earlier and later studies used NordDRG-grouped Danish data.

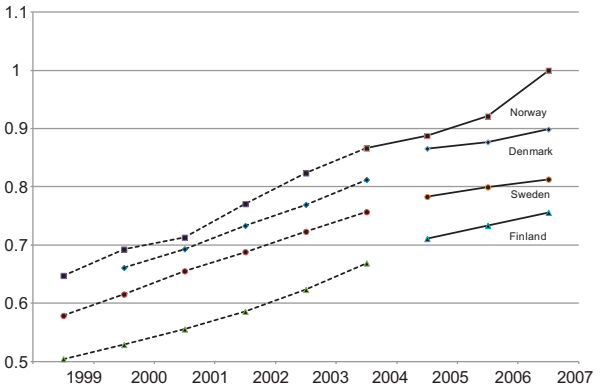

Fig. 1. Relative differences in the price index used in the analyses 1999–2007.

3.2. Input measurement

3.2.1. Operating costs

In all the studies the single input hospital costs included all production-related costs in a hospital, excluding capital costs and costs of teaching and research, with the exception of the university-hospital study where governmental budget appropriations for teaching and research activities also were included. The production-related costs were harmonized through a systematic review of the accounting cost structure in each country. Capital costs were excluded because of large dissimilarities in how the costs are registered across and within countries.

3.2.2. Relative input price index

To harmonize the cost level between the four countries over time a wage based price index was constructed. In the first Norway-Finland comparison the hospital's total wage expenditures were divided by the number of FTEs to construct a wage index for each hospital. For 60% of the hospital-operating costs the wage index was used and for 40% (e.g. materials, equipment and rents) a purchasing power parity (PPP) conversion adjustment was used [12]. In the next study the input price index was estimated by weighing 50% of hospital-operating costs with the wage index based nurses' wages, 20% with the wage index based on physicians' wages, and the remaining 30% using the PPP conversion adjustment [15]. In the latest study the price index was further developed [16,17]. Indices for physicians, nurses and four other groups of hospital staff were constructed, as well as one for "other resources". The wage indices were based on official wage data and included all personnel costs, i.e. pension costs and indirect labour taxes. The index for 'other resources' was the GDP purchaser power parity index from OECD. In some of the studies a Paasche-index using Finland was used as a reference point [12,14,15] whereas in others Norway was used [13,16,17]. Fig. 1 shows the relative input price level in common currency using Norway 2007 as the reference point and chained using the Norwegian cost level of 2004 calculated by both methods.

3.3. Method for analysis

3.3.1. Cost efficiency and technical productivity

It is of greatest importance to choose the right methods for the analysis [26]. Non-parametric approaches such as DEA have the disadvantage of assuming no statistical noise, but have the advantage requiring no assumptions about the production frontier. Stochastic cost frontier (SCF) models on the other hand allow for statistical noise, but have the disadvantage of being parametric and requiring strong assumptions about the inefficiency term and have been criticised for their potential for mixing statistical noise and inefficiency [27]. In the studies measuring cost-efficiency the non-parametric method DEA was used and estimations under assumptions of constant returns of scale (CRS) and variable returns of scale (VRS) were conducted [12,14,15] and in later studies bootstrapping techniques was used [22] to provide confidence intervals to the efficiency and productivity scores and to correct from bias [13–17]. In the technical productivity comparisons the DEA and statistical frontier analysis (SFA) was used [13,16,17]. Second stage regression analyses, aiming at explaining the differences in results by external circumstances were introduced in the Norwegian reform assessment where the Norwegian health care reform seemed to have a positive effect on the hospital productivity levels and the outlier cases a negative association with the results [13]. The analysis was repeated in the later hospital productivity study with the addition a positive association between efficiency and outpatient share and a negative association with length of stay [16,17]. Further statistical analysis of the comparison between 2005 and 2007 was done with decomposition of the productivity differences into cost efficiency, scale efficiency and country specific effects. The analysis showed large differences of the country specific effects in terms of different frontiers and where the overall frontier was determined by the Finnish hospitals [16,17].

4. Discussion

From the experiences of conducting hospital productivity analysis in the Nordic countries a number of issues have been derived and identified as being important to consider in international cross country analyses. The first requirement for an international hospital productivity comparison is the existence of a common patient classification system that can adjust for case-mix differences in the outputs, e.g. a DRG system. A mapping system needs to be created that compiles the diagnosis and procedure classifications used in different countries into classifications that can be applied in a generic DRG classification grouper. Moreover, sufficient knowledge about the data generation process (including coding practices) needs to be obtained and information on outpatient activities that are not included in the DRG groups needs to be gathered. The characteristics of the hospitals in the Nordic region are suitable examples for international empirical efficiency comparisons as they provide datasets that are relatively comparable both in terms of inputs and outputs. In Europe most DRG systems are not comparable [23]. The classifications of clinical procedures are different, Nordic countries as an exception.

If mapping systems were to be created there is potential for productivity analysis using information about 600 hospitals in 11 OECD countries [1].

Furthermore, cost weights for each DRG group needs to be estimated. It is of greatest importance to clearly define the DMU and make sure they are as comparable as possible (university hospitals vs. regional hospitals vs. local hospitals) and make sure similar definitions for inputs (expenditure or manpower) and outputs (patients, discharges and outpatient visits) at the level for the DMU as efficiency measures are highly sensitive to the operationalisation of hospital output [12,24,25]. In addition, in some hospitals the teaching and medical research activities use a considerable amount of resources, which should be taken into account in the estimation of the inputs for example, by deducting their cost from total costs, including measures of teaching and research outputs or performing separate analysis according to teaching/research status of hospitals. Lastly, to estimate productivity and efficiency one needs a comparable measure of the use of real resources that is corrected for differences in input wages and prices when expenditure is used as an input.

Although the issues mentioned above have been considered in the Nordic hospital productivity studies the above described analyses still show substantial differences in average empirical efficiency estimates across the countries. One obvious potentially explaining factor yet to be included is the quality of the outputs. In the context of the European Health Care Outcomes, Performance and Efficiency (EuroHOPE) measures of patient-level indicators of the quality of acute somatic care for international productivity comparisons will be developed. Quality indicators will include hospital mortality, out-of hospital mortality, readmissions and waiting time based on patient level data available from linkable national registers. In addition, in order to decide if the differences in the empirical efficiency results are associated with patient, regional or hospital specific characteristics the extension of standard performance measurement methods to multi-level regression analyses of patient-level quality indicators and hospital level activity will be explored. Finally, to enhance the output measurement a 'common Nordic grouper' developed specifically for this project and in cooperation with the Nordic Casemix Centre will be used in the forthcoming studies.

5. Conclusions

The hospital sectors in the Nordic countries provides good examples for international comparison as the characteristics of their hospitals in many ways are harmonised; they have administrative data at the hospital level, they all apply a similar secondary patient classification system and they exhibit a rather similar structure of the organisation for hospital care. In addition the hospital sectors provide inputs defined in a similar way and data on differences in wages across different group of staff is available which makes the development of a relative price index possible. Patient-level data available from linkable national registers enables the development of quality indicators and multilevel regression analysis will be explored in the forthcoming hospital productivity studies in the context of the EuroHOPE project.

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